Center for Advanced Automotive Technology

C · A · A · T

Automotive Technology

You Cannot See the Future in the Rearview Mirror

Bob Feldmaier

101 People, Places, and Things Made in Michigan

March 18, 2015

Macomb Community College

Education • Enrichment • Economic Development

Discover. Connect. *Advance.*

NSF

WAYNE STATE

Industry Needs in Advanced Automotive Technology

Transportation Challenges

Safety
32,367 highway deaths in 2011
5.3 million crashes in 2011
Leading cause of death for ages 4, 11–27

Mobility
5.5 billion hours of travel delay
$121 billion cost of urban congestion

Environment
2.9 billion gallons of wasted fuel
56 billion lbs of additional CO_2

“Auto Jobs go High-Tech”

- Nearly half of Michigan’s auto jobs now outside of the factory; will soon be majority.
- “Detroit is still the intellectual capital of the auto industry.”
- Michigan ranks #1 in concentration of engineers (65,000).
- Number of technical jobs expected to grow as industry technology becomes even more advanced.
- Many foreign auto makers and suppliers have set up technical centers in Michigan (Toyota, Hyundai, Bosch, et al).

See *Detroit News*, January 26, 2014, citing multiple sources

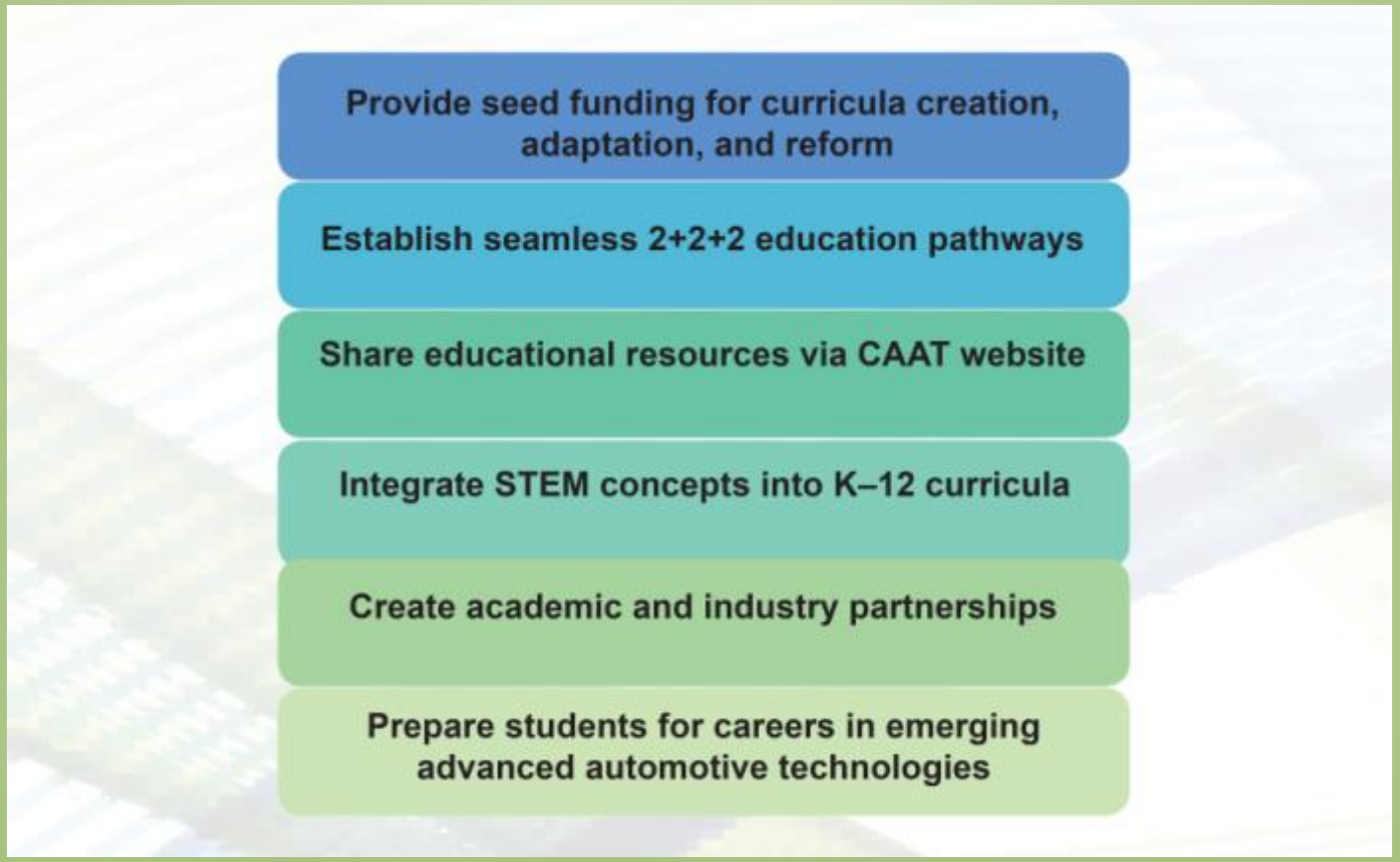
About the Center for Advanced Automotive Technology (CAAT)

- Located at Macomb Community College South Campus
- Partnered with Wayne State University
- Became an Advanced Technological Education Center in 2010 funded by the National Science Foundation ($2.8M Grant)
- Mission
  - Advance the preparation of skilled technicians for the automotive industry's more environmentally friendly and safer vehicles.
  - Be a regional resource for developing and disseminating advanced automotive technology education.

Why CAAT at Macomb Community College?

- Long history of preparing many students to work in the industry
- Leaders of advanced automotive curriculum development for technicians
- Located in the heart of the rejuvenated US auto industry
  - Over 215 Automotive R&D Companies in Michigan
  - Most (85%) are clustered in southeast Michigan
  - 60% of the top 150 automotive suppliers to North America are headquartered in Michigan
- Executing a number of related Energy and Automotive grants

CAAT's Strategic Plan



Strength and Value through Partnerships

Our Strategic Partners

CAAT's NSF Grant is Renewed for 3 More Years

- Received additional NSF funding of $2.0M through July 31, 2017
- Mission remains preparing technicians and technologists to work on advanced automotive technology
- Technical scope:
  - Continues to support vehicle electrification and other automotive propulsion technologies
  - Expands to include the materials lightweighting and automated and connected vehicles

Drivers of the Auto Industry Future within CAAT's Scope

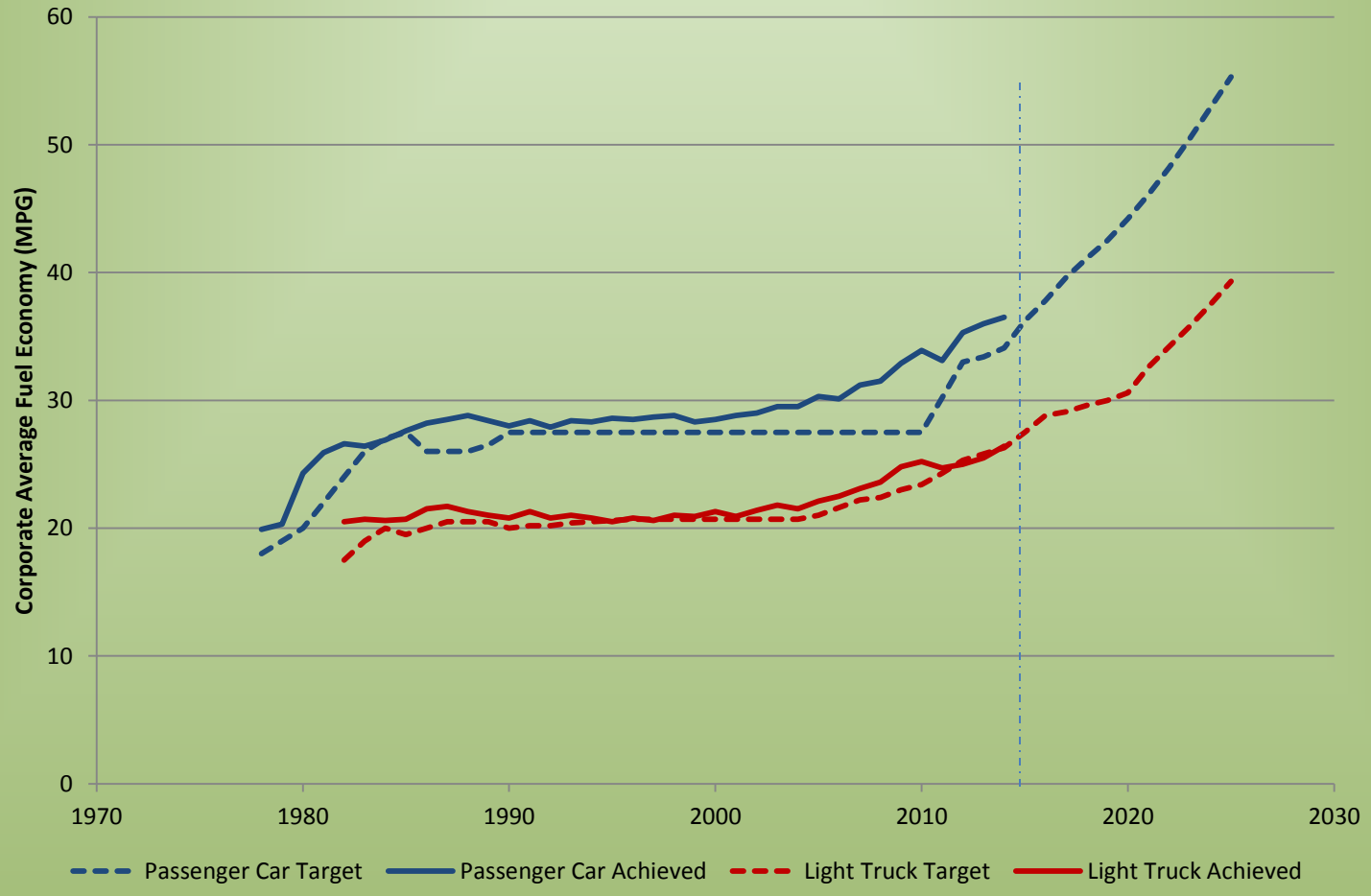
Source: Automotive Industry Office, Michigan Economic Development Corporation

WardsAuto Annual Survey of Industry Engineers on Fuel Economy Strategies

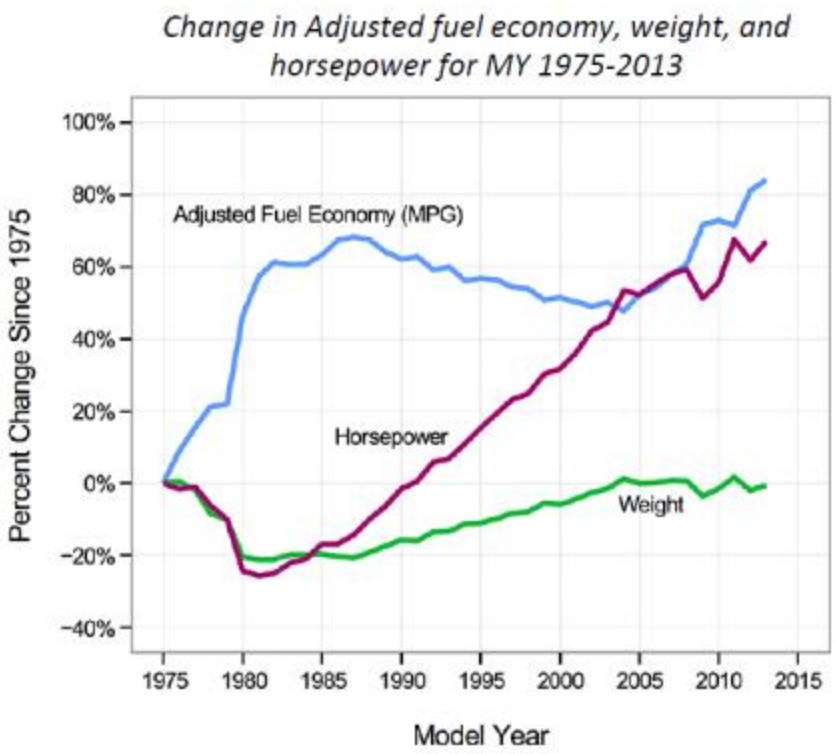
- Question: What technology is your company focused on to help the industry meet 2025 fuel economy standards (multiple answers permitted)?
  - 49%, lightweighting
  - 39%, engine efficiency
  - 26%, vehicle electrification
  - 11%, downsizing
- For the 2011 survey, engine efficiency was the area of largest focus.

Source: 2014 WardsAuto, DuPont Automotive Trends Benchmark Study

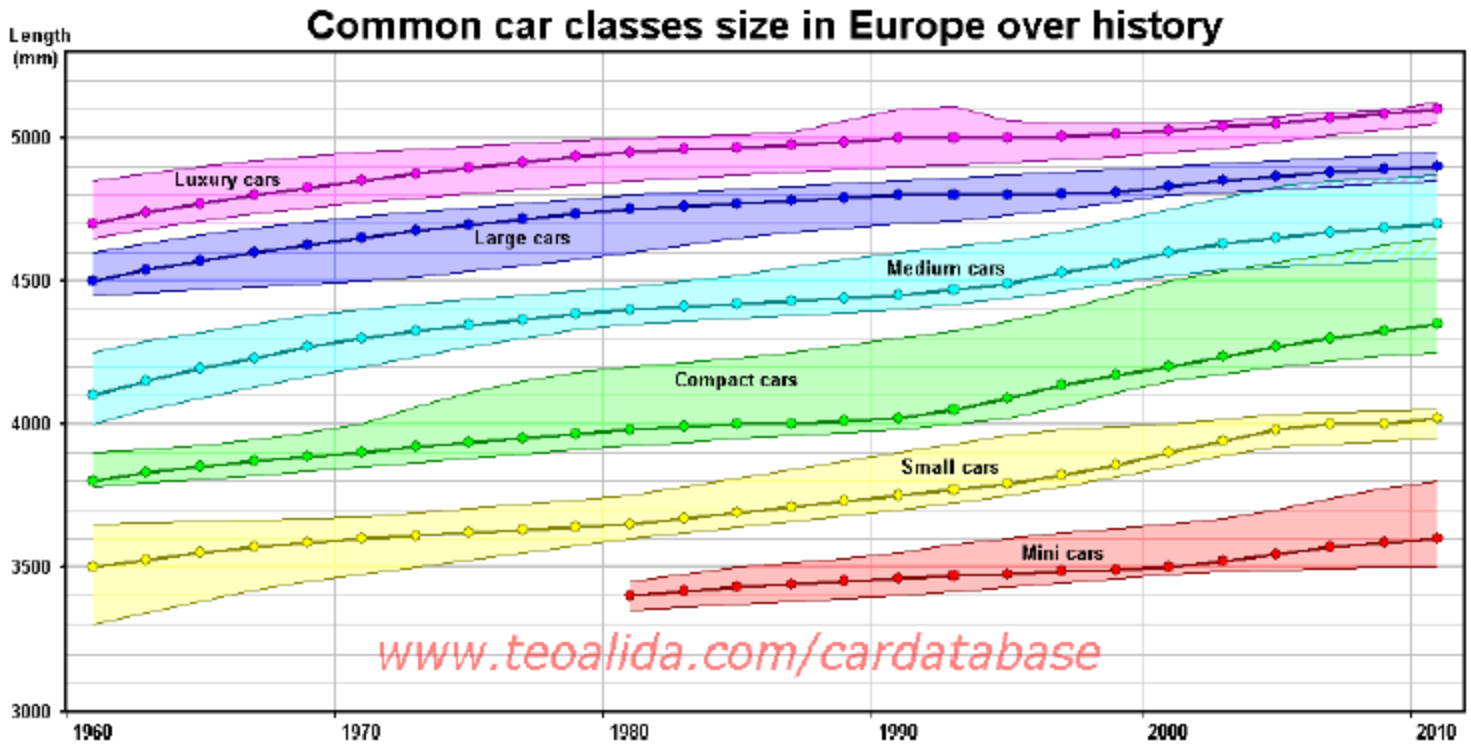
Future Corporate Average Fuel Economy (CAFE) Standards Are Very Tough



History of Vehicle Mass, Power, and Fuel Economy

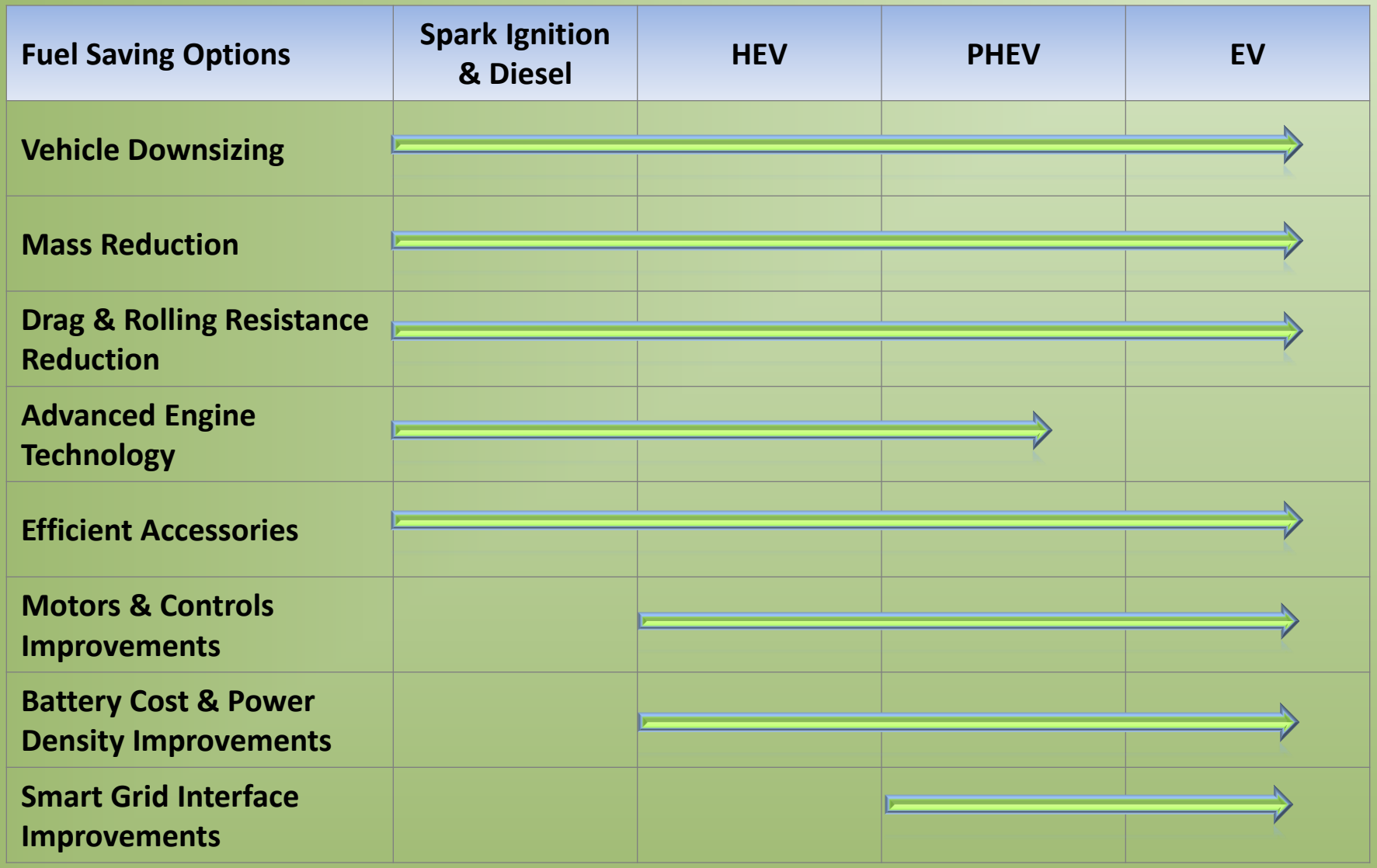


Trend of Historical Vehicle Size Increases (Europe)

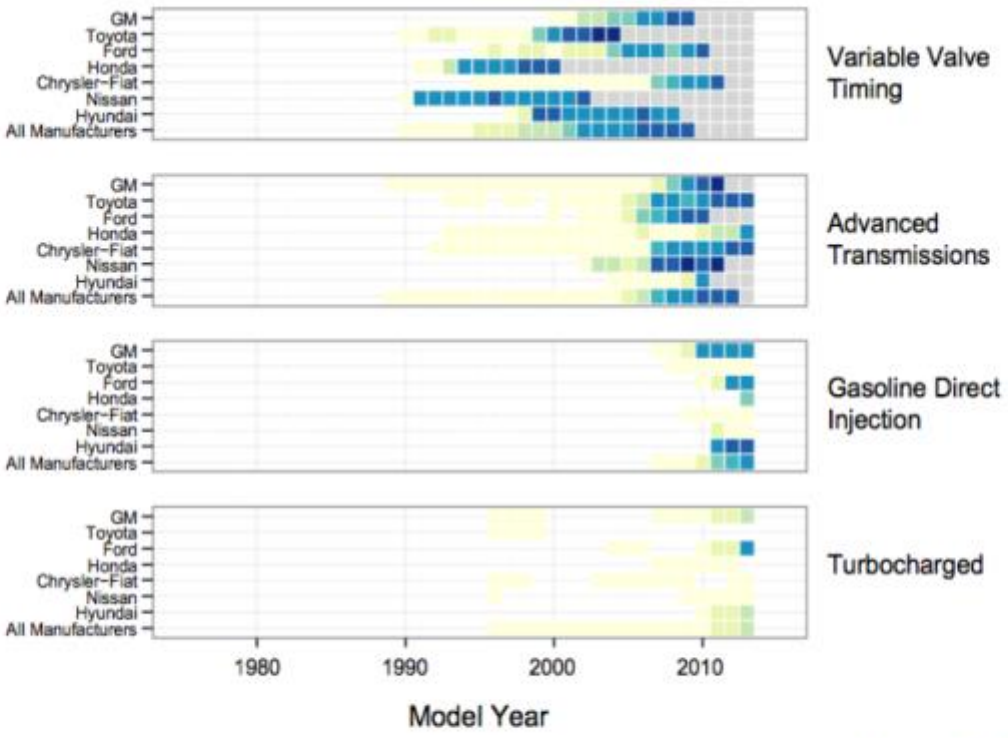


Example of the Old vs New Fiat 500

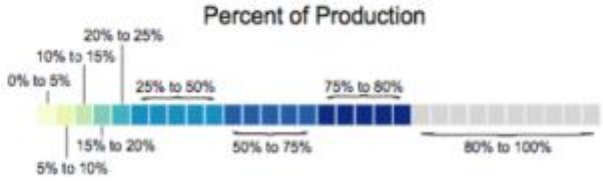
Fuel Saving Technologies Apply across Vehicle Types



Advanced Powertrain Technologies Are Being Widely Applied



Green Car Congress, Dec 2013



Types of Electrified Vehicles

- HEV - Hybrid Electric Vehicle
- PHEV – Plug-In Hybrid Electric Vehicle
- BEV – Battery Electric Vehicle

HEV – Hybrid Electric Vehicle

- A combination of 2 inputs usually gas and electric
- No plug into an outlet
- ICE/Gas Engine is the main power source
- Different types
  - Micro
  - Mild
  - Medium
  - Full/Strong
- Sales plateaued at 3%

Chevy Volt

Ford Escape

PHEV - Plug In Hybrids

- Outlet for plugging in to charge a larger battery pack
- Can go limited number of miles on a charge before the ICE kicks in
- Has an ICE
- Sales growing

Toyota Prius

Ford Focus

BEV- Battery Electric Vehicles

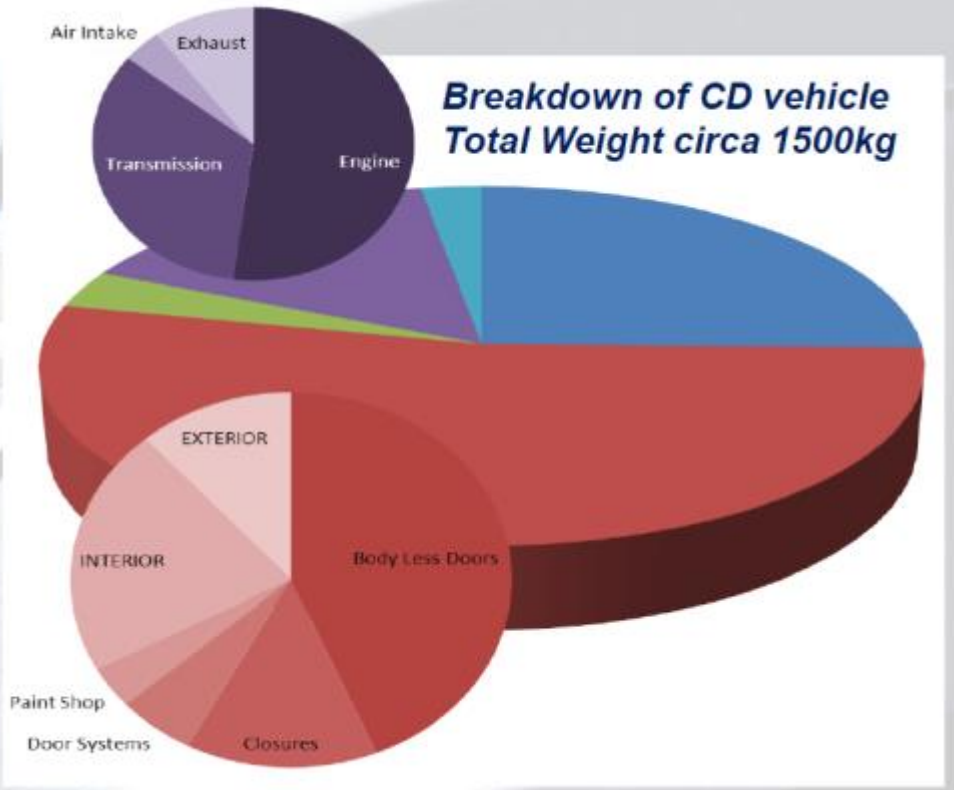
- All electric
- Range depending on manufacturer and size of battery pack
- Range anxiety
- Nissan Leaf, Ford Focus
- Small, niche market

Nissan Leaf

Tesla Roadster

Typical Vehicle Mass Break-Down by System (Land Rover)

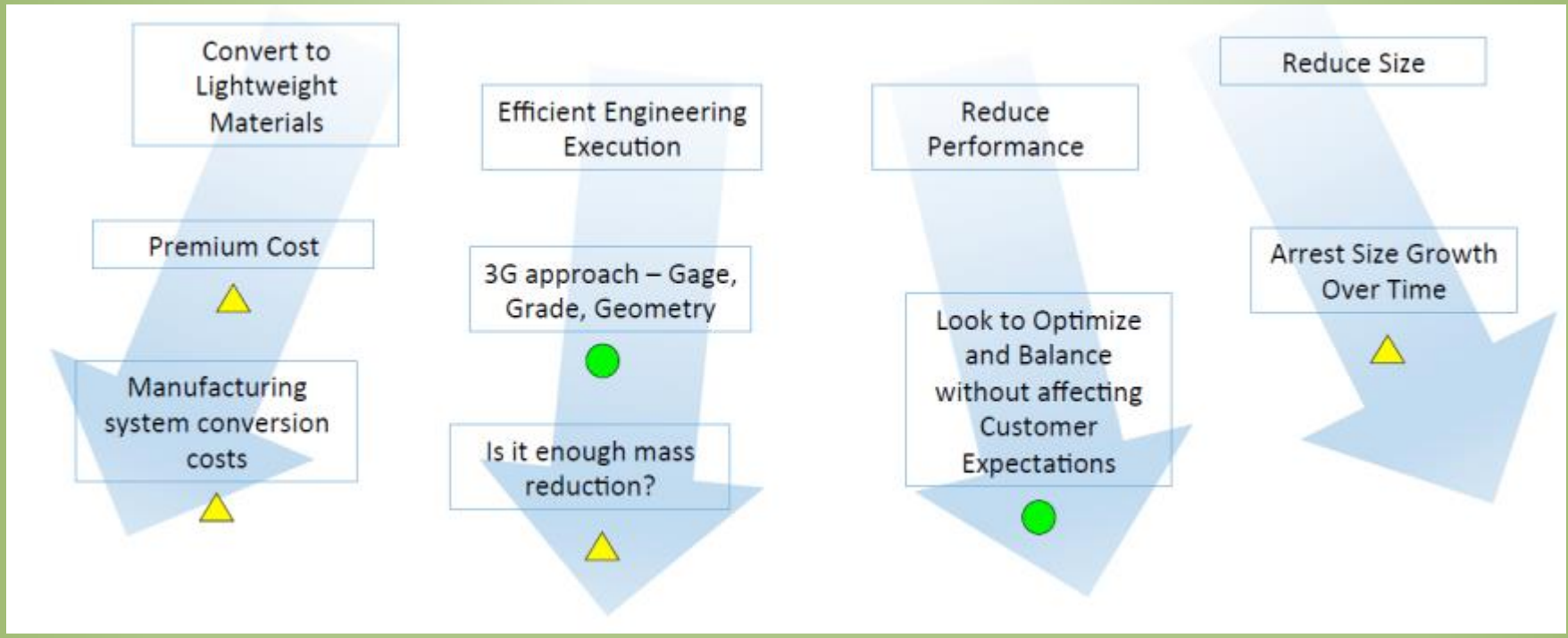
- CHASSIS SYSTEMS
- BODY SYSTEMS
- ELECTRICAL SYSTEMS
- POWER TRAIN SYSTEMS
- CLIMATE SYSTEMS



How Does Mass Reduction Achieve Fuel Economy Savings?

- Less energy required to accelerate the vehicle (F=ma)
- Less rolling resistance at speed
- Lightweighting begets lightweighting:
  - Smaller powertrains
  - Lighter chassis and brake components
  - Smaller gas tanks/batteries
  - Smaller wheels and tires

Mass Reduction Approaches for Body Structures and Closures

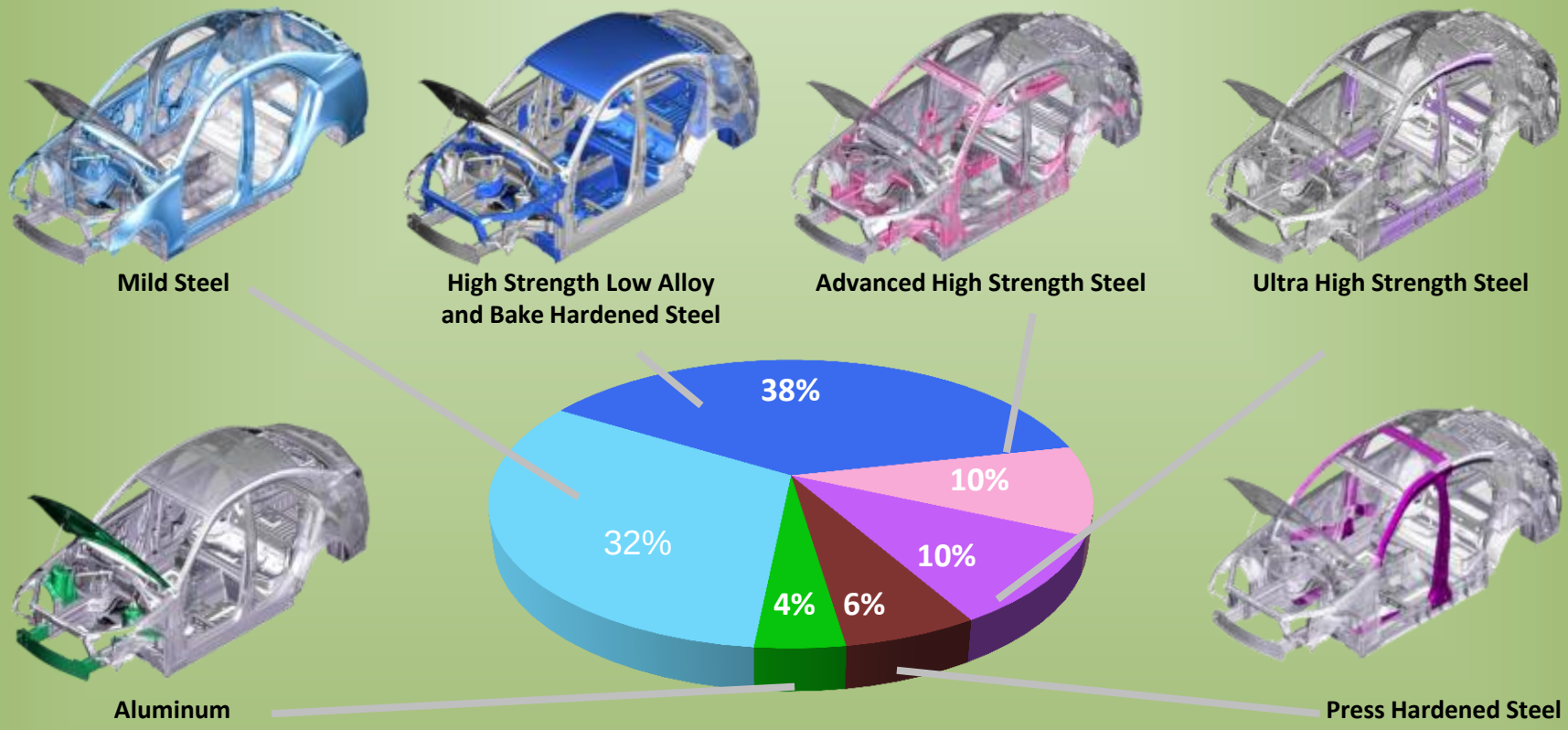


Examples of Sustained Applications of Lightweight Materials

- Aluminum Castings
  - Engine blocks and heads
  - Transmissions
  - Heat Exchangers
- Advanced High Strength Steels
- Aluminum Closure Panels

Multiple Materials In Body-In-White

- ATS Example:



Material Distribution as a Percent of BIW Mass

Assemblies of Advanced and Multiple Materials Complicate Joining

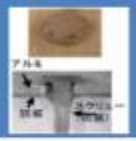
6. Multiple material

TOYOTA

Joining technology

○=Candidates to use/develop in Toyota

LSS: Low Strength Steels
HSS: High Strength Steels (~780MPa)
USS: Ultra High Strength Steels , Hot Stamping Steels (980MPa~)
AL : Aluminum

Combination of materials	SPR Self Piercing Rivet	FDS Flow Drill Screw	FSW Friction Stir Welding	FSJ Friction Spot Joining	LSW Laser Screw Welding	adhesive	・・・
							
Steel x Steel					○	○	
AL x AL	○	○	○		○	○	
Steel (LSS,HSS) x AL	○	○	○	○		○	
Steel(UHSS) x AL			○	○		○	
AL x CFRP(Random)	○			○		○	
Steel (UHSS) xCFRP(Random)	○			○		○	
CFRP x CFRP	○			○		○	
:							

Develop the most suitable Joining technologies for each material combination and each location

Typical Worker Skills Required in the Field of Lightweight Vehicles

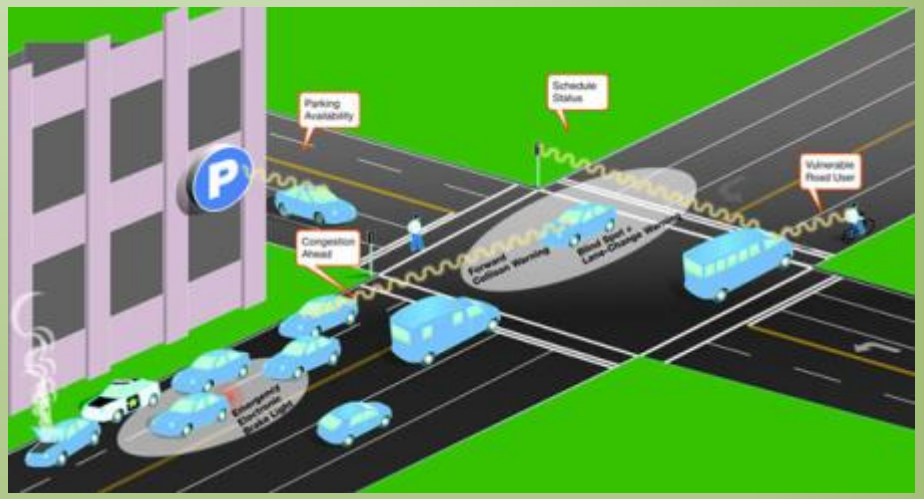
- Designers
  - Understanding of automotive materials properties for design including strength, stiffness, formability, joining methods, reparability, and recycling.
  - Familiarity with proven, sustainable automotive material choices
  - Understanding of systems engineering, CAE modeling , and manufacturing systems
- Technicians
  - Knowledge of how and when to repair many different automotive materials
  - Ability to assess and repair many different types of automotive joints and complex assemblies
  - Familiarity with how to identify and sort materials for reprocessing

The Need for Connected Cars

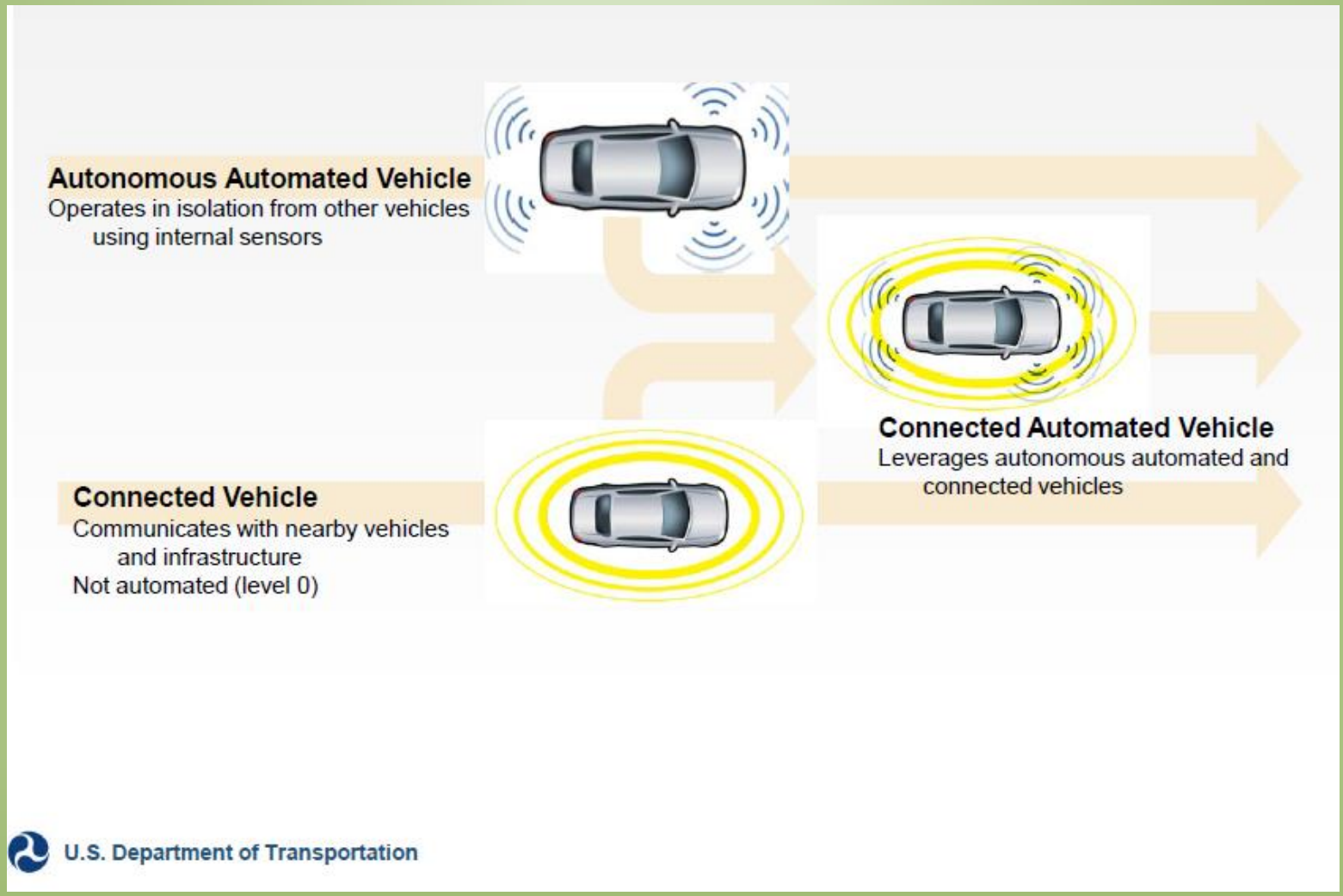
- To make cars safer and more reliable
- To optimize performance
- For the convenience and luxury of passengers

Connected & Automated Vehicles Defined

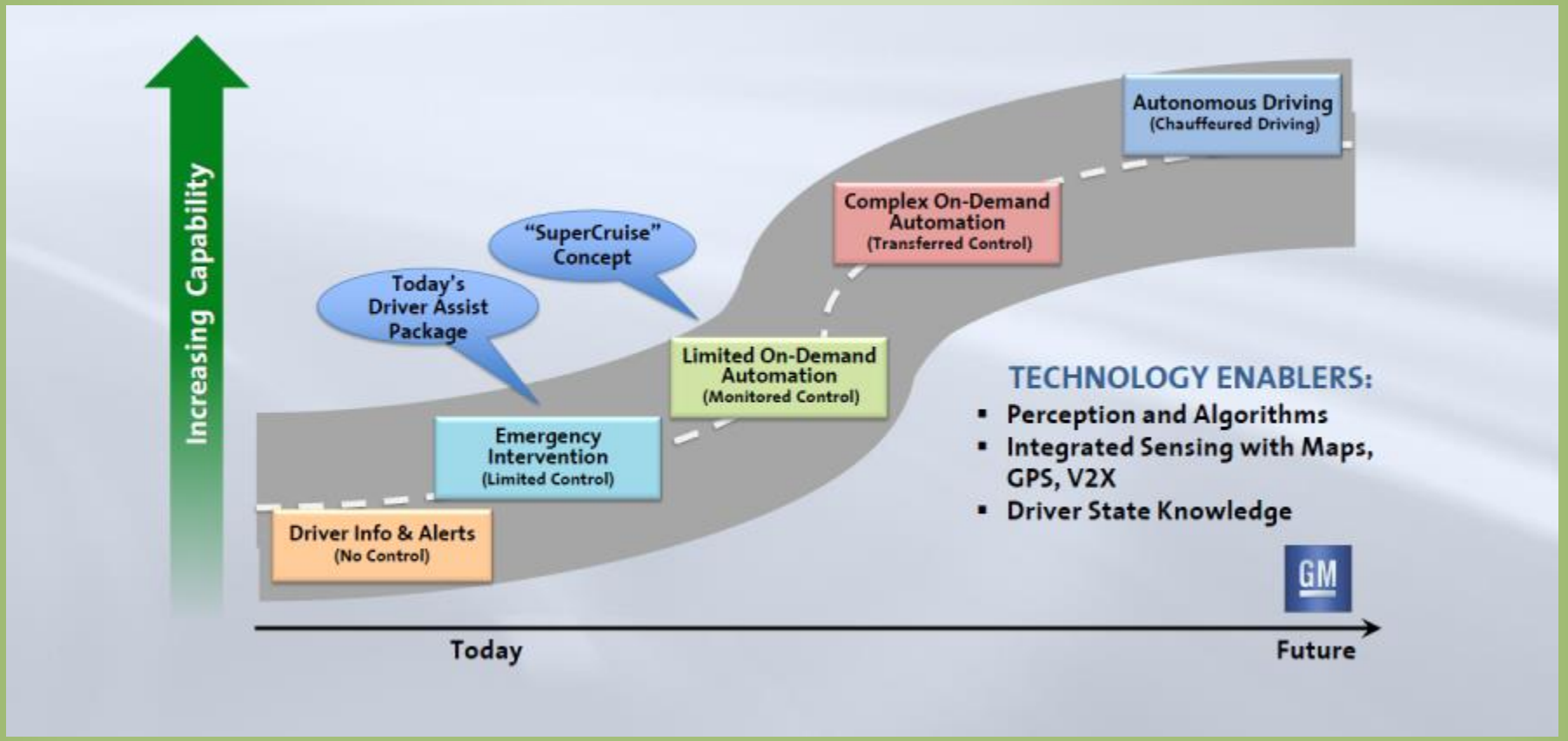
- Connected and automated vehicles use any of a number of different communication technologies to communicate with:
  - The driver
  - Each other
  - Roadside infrastructure
  - The “Cloud”
  - Satellites



Automated and Connected Vehicles



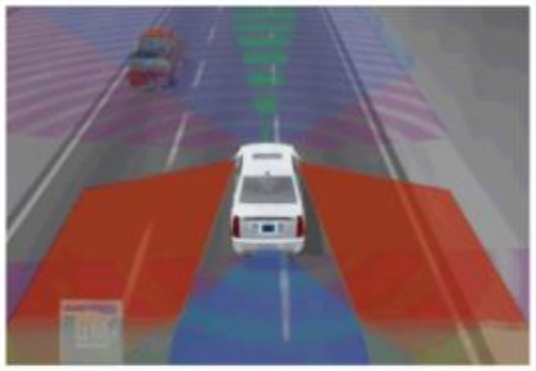
GM's Road to Automated Driving



NHTSA's Levels of Automation

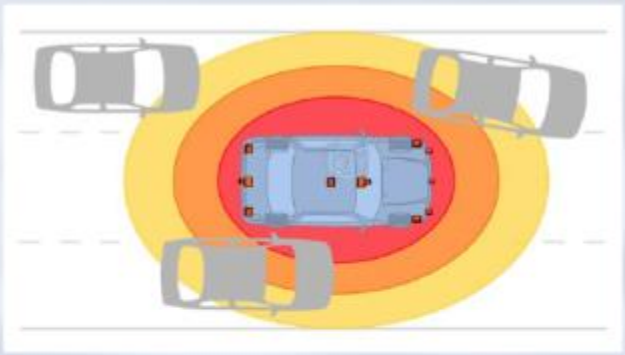
Integrated Systems Approach to Vehicle Automation

360° SENSING



MAPS/GPS

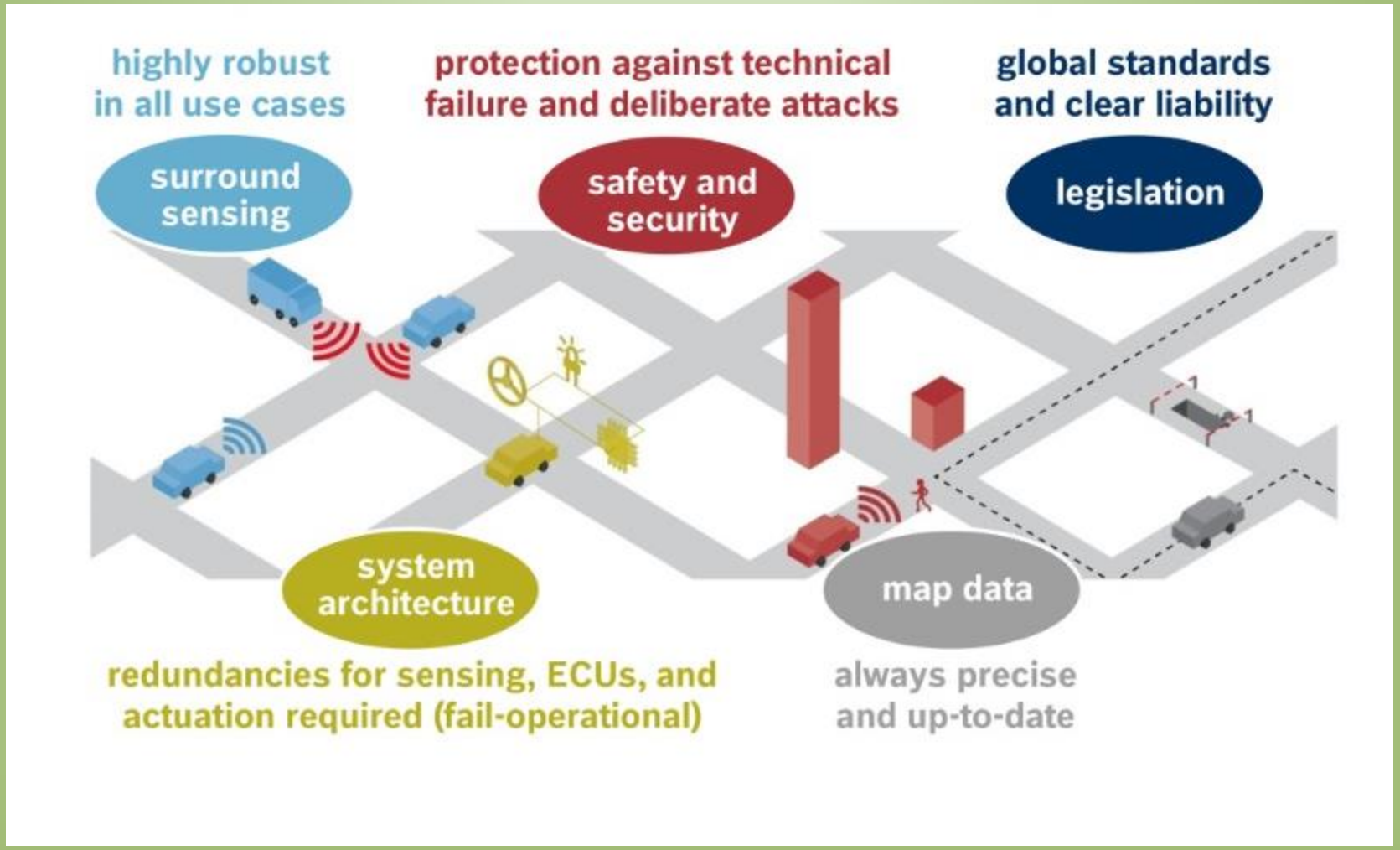
SENSOR FUSION



V2V/V2I INTEGRATION

Coming application: 2017 Cadillac “Super Cruise”

The Complexity of Automated Driving



As for the PC Market, History Repeats Itself: Changing the Automotive Value Stream

November 6, 2013

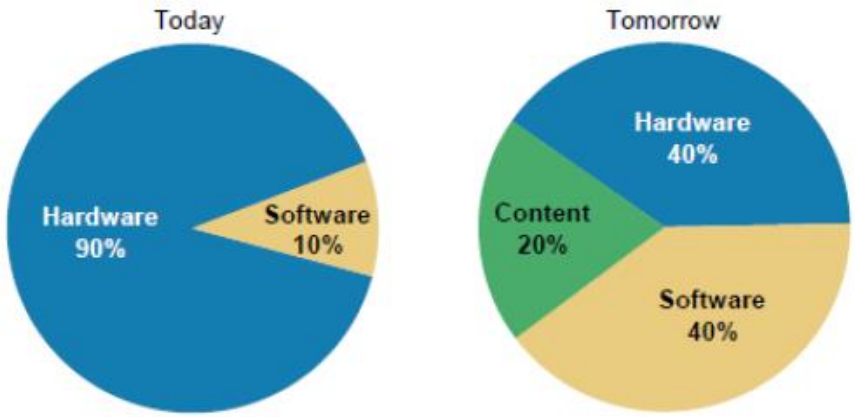
MORGAN STANLEY BLUE PAPER

Autonomous Cars

Self-Driving the New Auto Industry Paradigm

Exhibit 59

Value of the Car – Today vs. Tomorrow



Source: Morgan Stanley Research

Typical Technician Skills Required in the Field of Automated Vehicles

- Basic automotive and prototype shop knowledge (teardown vehicles, build harnesses, basic fabrication skills, troubleshoot auto systems without manuals)
- Electronics skills (ECMs, sensors and sensor fusion, antennas, CAN and cable protocols, displays, soldering, shielding, troubleshooting)
- Software Skills (embedded systems, basic programming, networks, security systems, user interfaces)
- Understanding of Communication protocols (Satellite, LTE/cellular, WiFi, DSRC, Bluetooth)
- Lab testing and data analysis

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- Visit our website at www.autocaat.org
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- Follow us on social media
- Plan to attend the FREE CAAT Conference on May 1, 2015
- Work with us on your workforce development, curriculum development, and credentialing initiatives


CAAT e-Blast | February 2014

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Register Now to Attend the FREE 2014 CAAT Conference

This FREE conference, *You Can't See the Future in the Rearview Mirror*, will be held on Friday, May 2, 2014 at Macomb Community College's South Campus in Warren, MI. Don't miss your opportunity to learn more about the future of the automotive industry from our keynote

Michigan's Senior Automotive Advisor Visits the Center for Advanced Automotive Technology

Nigel Francis, senior automotive adviser to the state of Michigan and senior vice president, Automotive Industry Office, Michigan Economic Development Corporation, visited the CAAT earlier this month. Nigel is charged with developing, implementing, and executing a comprehensive strategic plan and road map to promote, retain, and grow the automotive industry in Michigan. He serves as the state's central connection point for automotive industry stakeholders and engages with them to drive action that supports the industry and Michigan's overall economic growth strategy.

Nigel Francis

During his visit, Mr. Francis shared with the CAAT key components of his comprehensive strategy to drive

Thank You!

Questions?